STEEL WIRE WITH BRIGHT LOOKING SURFACE

Field of the invention.

The present invention relates to a coated steel wire having a bright looking colored surface and to a method of manufacturing a coated steel wire having a bright looking colored surface.

Background of the invention.

A number of attempts have already been made to give to a steel wire a bright looking surface and to maintain an acceptable level of brightness during the life of the wire. All of these attempts, however, have some major disadvantages.

One of these attempts has consisted in galvanizing a steel wire and enameling the galvanized steel wire so that a lacquered wire is obtained. Such a lacquered wire has the advantage of having an excellent corrosion resistance due to the duplex layer "zinc + lacquer" and the advantage of offering a variety of colors. Experience, however, has shown that for applications where the wire is subjected to high mechanical deformations, the lacquer does not stick on the surface of the wire due to its inherent lack of tenacity.
Still another problem is the relatively high coefficient of friction of lacquer coatings. This considerably slows down the speed of the downstream processing of the lacquered steel wire.

Summary of the invention.

It is an object of the present invention to provide a corrosion resistant steel wire with a bright, preferably colored surface.
It is another object of the present invention to provide a steel wire with a typical metallic looking color.
It is also an object of the present invention to provide a steel wire with transparent colored coating which conserves its transparency.

US-A-4 358 887 discloses a pipe, hot dipped with zinc and plastic coated with polyester. Between the zinc coating and the polyester coating is a chromate compound.

EP-A-0 791 453 discloses a galvanized strip. On the zinc coating is a bonding layer and on the bonding layer is a polymer coating such as a polyester coating with a dye.

It is still another object of the present invention to provide an adherent coating to a bright steel wire without much decreasing the original degree of brightness of the steel wire.

It is yet another object of the present invention to provide an environment friendly method of giving a bright metallic looking color to a steel wire.

According to a first aspect of the present invention, there is provided a steel wire with a bright looking and ~~preferably~~ colored surface. The steel wire is covered with an intermediate coating layer which gives the brightness to the steel wire and is further coated with a ~~polymer being selected from the group consisting of~~ thermoplastic polyesters, ~~polyimides, polyamides, polycarbonates, crystalline polyvinylchlorides and polyphtalamides~~. This ~~polymer~~ is transparent. The ~~polymer~~ is ~~preferably~~ colored, e.g. by comprising a transparent coloring agent, which can be added to the ~~polymer~~ in the form of small grains in a carrier of a similar or same ~~polymer~~. The coloring agent may be organic. An immediate advantage is that a variety of embodiments are possible depending upon the concentration and type of coloring agent. Metallic like colors and fluorescent colors may be applied to the steel wire in this way.

In comparison with a lacquer coating, these transparent ~~polymers~~ are more tenacious and have a lower coefficient of friction. A friction force test demonstrates that ~~a nylon coating or~~ a polyethylene terephtalate coating provides a friction resistance which is three times smaller than the friction resistance of a zinc coating.

~~The group~~ of polyimides comprises polyamide imide, polyester imide, polyether imide and ~~polyanyl imide~~. Polyamide imide, as a matter of example, provides a good adh sion and has a high ~~melting point~~.

Preferably the coating is a thermoplastic polyester such as polyethylene terephtalate ("PET"), polybutylene terephtalate ("PBT") and polyethylene naphtenate ("PEN").
The most preferable embodiment amongst these is polyethylene terephtalate, since it combines the better properties such as high tenacity, low humidity absorption with a relatively low cost.

Within the context of the present invention, the terms "polyethylene terephtalate" or "PET" denote not only homopolymers of ethylene therephtalate but also copolymers of ethylene terephtalate containing not more than 20% of other copolymerized units, e.g. derived from other acids than terephtalic acid, such as isophtalic acid or from other glycols than ethylene glycol. The polymer may also contain mixtures of polymers in order to modify certain of the properties thereof.

The polyethylene terephtalate coating is more than 50% amorphous, and preferably more than 70% amorphous. This may be achieved by rapid cooling after the extrusion process. In comparison with a crystalline structure of the coating, an amorphous polyethylene terephtalate coating, for example, has a more pronounced luster and is more flexible. Recrystallisation, however, may occur in course of time. In comparison with a PBT coating, recrystallisation happens much slower with a polyethylene terephtalate coating. This is an advantage for a polyethylene terephtalate coating over PBT coating.

In comparison with coatings of polyamides such as nylon-6 (PA6), a polyethylene terephtalate coating has a better adhesion and adhesion retention, has a higher corrosion resistance, has a better resistance against ultra-violet light (= better weatherability) and has a lower absorption of water or moisture, and, as a consequence, maintains much better its original degree of transparency and luster. More particularly, polyethylene terephtalate coating absorbs only one tenth of the amount

of moisture absorbed by a nylon-6 coating in the same circumstances. Moreover, application of a polyethylene terephtalate coating can be done in an environment-friendly way, i.e. with a much more simpler pre-treatment without the use of chromic acids which would otherwise decrease the degree of brightness and without the use of primers which could also jeopardize the original degree of brightness.

One way of giving the original brightness to the steel wire is by applying an intermediate metallic coating such as a copper coating, a copper alloy coating such as bronze or brass, a zinc coating, a zinc alloy coating such as a 95% zinc 5% aluminum alloy, a nickel coating, a nickel alloy coating, a tin coating, or a tin alloy coating.

Another way of giving the original brightness to the steel wire is by applying an intermediate coating such as a copper-tin sulfate coating or a copper-sulfate coating.

The degree of brightness of the steel wire can be quantified on the bright intermediate coating of the steel wire, either before coating with the transparent polymer, or after removal of the transparent polymer. This quantification has the advantage of being independent of the color of the polymer and of the thickness of the polymer. The degree of brightness of the steel wire can also be quantified on the final steel wire, i.e. coated with the transparent polymer, but may have the disadvantage of being dependent upon the color of the polymer, if any, and upon the thickness of the polymer.

The quantification can be done either by determining the peripheral roughness of the steel wire or by determining the so-called L-value of the steel wire.

According to a second aspect of the present invention, there is provided a method of manufacturing a steel wire having a bright looking colored surface. The method comprises the following steps :

(a) providing a steel wire ;

(b) coating the steel wire with an intermediate coating layer ;

(c) giving a degree of brightness to the intermediate coating ;

(d) coloring a polymer e.g. by adding a coloring agent to the polymer, where the polymer is selected from the group consisting of thermoplastic polyesters, polyimides, polyamides, polycarbonates and polyphtalamides;

(e) further coating the bright steel wire with the polymer (16).

The coating of the steel wire with the intermediate coating layer can be done by means of a hot dip operation, or by means of an electrolytic coating process.

A required degree of brightness can be given to the intermediate coating layer by wet drawing the intermediately coated steel wire in a suitable lubricant.

However, wet drawing is not necessary to obtain the required degree of brightness. This required degree of brightness can also be obtained on the steel wire on its final diameter by suitably cooling the wire immediately after it leaves the bath in a hot dip galvanizing operation, or by electroplating the steel wire.

The further coating with a transparent polymer can be done by means of an extrusion process.

The invention is particularly applicable to steel wires which are subjected to high mechanical deformations.

For low carbon steel wire, which is steel wire with a carbon content b low 0.20 %, following types of wires are subject d to high mechanical

deformations : bookbinding wire, box stapling wire, weaving wire, mattress wire, paper clip wire, coat hanger wire, bucket wire, tie wire, lamp shade wire, decoration wire, braiding wire, stitching wire ...
A typical diameter range for bookbinding wire is from 0.60 mm to 1.80 mm.
For high carbon steel wire, which is steel wire with a carbon content above 0.25 %, a spoke wire may be subjected to high mechanical deformation. A spoke wire coated according to the invention and having a fluorescent color may be particularly advantageous with respect to security.

Brief description of the drawings.

The invention will now be described into more detail with reference to the accompanying drawing being

- FIGURE 1, which shows a transversal cross-section of a steel wire according to the invention.

Description of a preferred embodiment of the invention.

FIGURE 1 represents a transversal cross-section of a steel wire 10 according to the invention. The steel wire 10 comprises a steel core 12, a thin coating 14 of wet drawn zinc so that a bright appearance is obtained and an outer coating 16 of transparent polyethelene terephtalate. The coating 16 of polyethylene terephtalate comprises a transparent organic coloring agent which gives to the steel wire 10 a bright and metallic like appearance.

Such a steel wire according to the invention can be manufactured as follows.
Starting material is a low carbon wire rod with a diameter of about 5.5 mm. This wire rod is dry drawn until an intermediate diameter of 3.0 mm. The thus drawn steel wir is subjected to heat treatment and is hot dip galvaniz d at this int rmediate diameter of 3.0 mm. The galvanized

steel wire is now wet drawn in a soap solution until a final diameter of 1.2 mm. This wet drawing gives the galvanized steel wire its bright appearance. The drawn steel wire is degreased in order to remove all remaining drawing lubricants from the surface of the steel wire. Finally, a transparant polyethylene terephtalate coating with transparent organic coloring agents is applied to the steel wire. The thickness of the polyethylene terephtalate is coating is about 35 micrometer (35 µm). Conveniently, these thicknesses range from 10 µm to 200 µm, preferably from 25 µm to 50 µm. Typical values are 35 µm for bookbinding wire and 50 µm for spoke wire.

The thus obtained invention steel wire is suitable for use as a bookbinding wire. The polyethylene terephtalate coating adheres well to the steel wire and can withstand the mechanical deformations to which a wires such as a bookbinding wire are normally subjected.